



US005891212A

United States Patent [19]

Tang et al.

[11] Patent Number: **5,891,212**
 [45] Date of Patent: **Apr. 6, 1999**

[54] APPARATUS AND METHOD FOR MAKING UNIFORMLY

[75] Inventors: **Jie Tang**, Ann Arbor, **Gary B. Hess**, Onsted, **Mark D. Muszynski**, Manchester; **Thomas S. Goehring**, Jackson, all of Mich

[73] Assignee **Aeroquip Corporation**, Maumee, Ohio

[21] Appl. No. **931,295**

[22] Filed **Sep. 16, 1997**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 892,145, Jul. 14, 1997, abandoned

[51] Int. Cl.⁶ **B06B 1/20**

[52] U.S. Cl. **75/335, 75/345; 264/9**

[58] Field of Search **75/331, 332, 335, 75/345, 264/9**

[56] References Cited

U S PATENT DOCUMENTS

3,986,899	10/1976	Kole et al.	148/24
4,216,178	8/1980	Anderson	264/9
4,302,166	11/1981	Fulwyle et al.	425/6
4,419,303	12/1983	Anderson	264/9
4,628,040	12/1986	Green et al.	508/8
4,744,821	5/1988	Yabuki et al.	75/340
4,787,935	11/1988	Eylon et al.	75/338
4,956,128	9/1990	Hommel et al.	264/4
4,981,625	1/1991	Rhim et al.	264/13
5,032,172	7/1991	Overtelt et al.	75/255
5,147,448	9/1992	Roberts et al.	75/331
5,171,360	12/1992	Orme et al.	75/331
5,226,948	7/1993	Orme et al.	75/331

5,266,098	11/1993	Chun et al.	75/335
5,411,602	5/1995	Hayes	148/23
5,520,715	5/1996	Orfening et al.	75/335
5,560,543	10/1996	Smith et al.	239/102 2
5,609,919	3/1997	Yuan et al.	
5,746,844	5/1998	Sterett et al.	75/335

FOREIGN PATENT DOCUMENTS

0467221	1/1992	European Pat Off	
2595595	9/1987	France	
6-91204	4/1994	Japan	239/102 2
1682039	10/1988	U S S R.	75/335
PCT/US98/11588	8/1998	WIPO	

OTHER PUBLICATIONS

Christian Henry Passow, *A Study of Spray Forming Using Uniform Droplet Sprays*, 1992, Thesis presented to the Department of Mechanical Engineering at MIT on May 5, 1992.

Primary Examiner—George Wyszomierski
 Attorney, Agent, or Firm—Emch, Schaffer, Schaub & Porcello, Co., L.P.A.

[57] ABSTRACT

Uniform sized and shaped spheres are formed by applying a minute periodic disturbance to a low viscosity liquid material. Pressure forces the material through at least one orifice in a crucible as a steady laminar stream. The stream enters an enclosed controlled temperature solidification environment which contains at least one heat transfer medium. A charging means is applied to the stream as the stream exits the crucible and breaks into a plurality of spheres to deflect the spheres as they pass through an electric field. The enclosed controlled temperature solidification environment cools and substantially solidifies the spheres.

28 Claims, 3 Drawing Sheets

